INDOOR AIR QUALITY ASSESSMENT

Summer Street School
262 Summer Street
Lynnfield, MA 01940

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program
August 2006

Background/Introduction

At the request of a parent and the Lynnfield Public School Department, the Massachusetts Department of Public Health (MDPH), Center for Environmental Health (CEH) provided assistance and consultation regarding indoor air quality at each of Lynnfield's public schools. These assessments were jointly coordinated through Patti Fabbri, Parent/IAQ Representative, Thom Forbes, Facilities Manager, Lynnfield Department of Public Works and Jim Nugent, Director, Lynnfield Health Department.

On May 9, 2006 a visit to conduct an assessment at the Summer Street School (SSS) was made by Sharon Lee, an Environmental Analyst in the Emergency Response/Indoor Air Quality (ER/IAQ) Program. Ms. Lee was accompanied during the assessment by Ms. Fabbri and Mr. Forbes.

The school is a one-story red brick building constructed in 1956. The original building underwent renovations in 2004 including an addition. The school is made up of general classrooms, kitchen, cafeteria, library, gymnasium locker rooms, music rooms, art rooms, computer rooms, an all purpose room and office space.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Hnu, Model 102 Snap-on Photo Ionization Detector (PID). Moisture content of water damaged materials was measured with a Delmhorst, BD-2000 Model, Moisture Detector equipped with a Delmhorst Standard Probe. CEH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The school houses approximately 540 students in grades K-4 and approximately 50 staff members. Tests were taken under normal operating conditions; however several classrooms were unoccupied due to end of the year activities. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in thirty-seven of forty-seven areas surveyed, indicating poor air exchange in the majority of areas surveyed. Fresh air in classrooms is supplied by a computerized unit ventilator (univent) system (Picture 1). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (Picture 2) and return air through an air intake located at the base of each unit. Fresh and return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit. Adjustable louvers control the ratio of outside to recirculated air (Figure 1). Univents were operating in all but one area (room 332), during the assessment. Obstructions to airflow, such as items stored on or in front of univents were seen in a number of areas (Picture 1). In order for univents to provide fresh air as designed, units must be activated while rooms are occupied and air diffusers should remain free of obstructions.

Mechanical exhaust ventilation in classrooms in the original building is provided by unit exhaust ventilators (Picture 3). A unit exhaust ventilator appears similar to a univent, but removes air from the classroom and exhausts it out of the building. Unit exhaust ventilators appeared to be off or operating weakly in several areas during the assessment. Without sufficient supply and exhaust ventilation, normally occurring environmental pollutants can build-up and lead to indoor air quality/comfort complaints. The mechanical exhaust ventilation system in the addition consists of wall-mounted exhaust vents (Picture 4) ducted to rooftop motors. As with the univents, wall-mounted exhaust vents were obstructed by various items limiting airflow.

Mechanical ventilation for interior rooms and common areas (e.g., offices, gym, media center) is provided by rooftop air handling units (AHUs). Fresh air is distributed to the classroom via ductwork connected to ceiling-mounted air diffusers. Return vents draw air back to the AHUs through wall or ceiling-mounted grilles. *These systems were operating during the assessment.* Local airflow to each air diffuser is controlled by a variable air volume (VAV) box. Each VAV box has a set of thermostat-controlled dampers that open or close depending on the temperature demand for a serviced area. Once the thermostat detects that the temperature has reached a predetermined level, the VAV box dampers close until heating or cooling is needed. VAV boxes also control the provision of fresh air to a serviced space. During times that the temperature of a space is adequate, the VAV box closes its damper and limits the amount of fresh air. In contrast, if the thermostat calls for the HVAC system to provide heat, the AHU fresh air intake damper would close to increase the temperature of the air in the ductwork and occupied spaces. Airflow would be noted from the ceiling air diffusers because the VAV box dampers are open, but fresh air supply would be limited by the closing of the rooftop fresh air intake damper.

While it has the advantage of energy conservation and lower operating costs, VAV box systems may cause problems of insufficient outside air supply. For example, once the temperature requirement is met, airflow drops. Airflow can drop to zero in poorly performing HVAC systems (Plog, Niland and Quinlan, 1996).

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems was not available at the time of the assessment, but should have occurred at some point after construction in 2004.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix A.

Temperature measurements ranged from 68° F to 74° F, which were within or close to the lower end of the MDPH recommended comfort guidelines in all but two areas surveyed. The MDPH recommends that indoor air temperatures be maintained in a range of 70 ° F to 78 ° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity ranged from 28 to 39 percent, which was below or close to the lower end of the MDPH recommended comfort range in all areas surveyed during the assessment. The MDPH recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. During the heating season, relative humidity levels would be expected to drop below the recommended comfort range. The sensation of dryness and irritation is common in a low relative humidity environment. For buildings in New England, periods of low relative humidity during the winter are often unavoidable.

Microbial/Moisture Concerns

An active plumbing leak was observed in room 113, which caused damage to insulation and wood coving (Pictures 5 and 6). The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Exposure to mold and related particulates can result in irritant symptoms particularly in sensitive individuals (i.e. those with pre-existing conditions such as asthma and allergies). In order for building materials to support mold growth, a source of moisture is necessary, in this case a plumbing leak. Identification and elimination of water moistening building materials is necessary to control mold growth. Materials with increased moisture content over normal concentrations may indicate the possible presence of mold growth. Identification of materials with increased moisture levels can also provide clues concerning the source of water supporting mold growth.

Water content of insulation and wood was measured with a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe. The Delmhorst probe is equipped with three lights as visual aids to determine moisture level. Readings, which activate the green light, indicate a sufficiently dry level, those that activate the yellow light indicate borderline conditions and those that activate the red light indicate elevated moisture content. Elevated moisture readings were measured in both insulation and wood in classroom 113 (Table 1).

Musty odors were reported by occupants in several classrooms along the perimeter of the building. The origin of the odor appeared to be from fresh mulch which had recently been spread prior to the CEH assessment. The area where the mulch is located is in close proximity to univent fresh air intakes (Picture 7), which can draw in odors and distribute them throughout the classroom.

Plants were noted in several classrooms and in close proximity to univent air intakes outside the building. Plants can be a source of pollen and mold, which can be respiratory irritants for some individuals. Plants should be properly maintained and equipped with drip pans. Plants should also be located away from ventilation sources (e.g., air intakes, univent diffusers) to prevent the entrainment and/or aerosolization of dirt, pollen or mold.

Exterior caulking around windows and frames was failing/damaged in a number of areas, indicating that the water seal is no longer intact (Pictures 8 and 9). Replacement of caulking and repairs of window leaks are necessary to prevent water penetration and subsequent damage to building materials, which can lead to mold growth. Missing/damaged mortar and spaces in brick was also observed on the exterior of the building (Picture 10). Repeated water penetration can result in the chronic wetting of building materials and potentially lead to microbial growth. In addition, these large cracks/holes in the exterior wall may provide a means of egress for pests/rodents into the building.

Spaces between the sink countertop and backsplash were noted in several classrooms (Picture 11/Table 1). Improper drainage or sink overflow can lead to water penetration to countertop wood, the cabinet interior and areas behind cabinets. Like other porous materials, if these materials become wet repeatedly they can provide a medium for mold growth.

Other Concerns

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants.

Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, CEH staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000a). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State

Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. On the day of assessment, outdoor carbon monoxide concentrations were non-detect (ND). Carbon monoxide levels measured in the school were also ND (Table 1).

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 microgram per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2000a). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 65 $\mu g/m^3$ over a 24-hour average (US EPA, 2000a). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective proposed PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 6 $\mu g/m^3$ (Table 1). PM2.5 levels measured in the school were between 6 to 35 $\mu g/m^3$, which were below the NAAQS of 65 $\mu g/m^3$ (Table 1). Frequently, indoor air levels of particulates can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulates during normal operation. Sources of indoor airborne particulate may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices, operating an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be negatively influenced by the presence of materials containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. An outdoor air sample was taken for comparison. Outdoor TVOC concentrations were ND. Indoor TVOC concentrations were also ND (Table 1).

Please note, TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC containing products. In an effort to identify materials that can potentially increase indoor TVOC concentrations, CEH staff examined classrooms for products containing these respiratory irritants. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Spray cleaning products and unlabelled spray bottles were observed on countertops in a number of classrooms (Pictures 12 and 13). Cleaning products contain VOCs and other chemicals, which can be irritating to the eyes, nose and throat and should be stored properly and kept out of reach of students. Many of these products appeared to be brought from home without the knowledge of school personnel who maintain material data safety sheets (MSDS) for chemicals used in the school. Therefore it is unlikely that MSDSs for these materials are available on site.

Several other conditions that can affect indoor air quality were noted during the assessment. In some classrooms items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provides a source for dusts to accumulate. These items, (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up.

A number of exhaust/return vents and personal fans had accumulated dust. If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize dust particles. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation.

In an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs (Picture 14) in a few classrooms. Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and cause TVOCs to off-gas. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as

Appendix B (NIOSH, 1998). Consideration should be made towards replacing tennis balls with alternative glides (Picture 15).

Conclusions/Recommendations

In view of findings at the time of assessment, the following recommendations are made:

1. Operate all ventilation systems throughout the building (e.g., gym, auditorium, classrooms) continuously during periods of school occupancy independent of thermostat control to maximize air exchange. To increase airflow in classrooms, set univent controls to “high”.
2. Inspect exhaust motors and belts for proper function. Repair and replace as necessary.
3. Work with town/school officials to develop a preventative maintenance program for all HVAC equipment system-wide.
4. Remove all blockages from univents to ensure adequate airflow.
5. Close classroom doors to improve air exchange.
6. Consider adopting a balancing schedule of every 5 years for mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
7. Change filters for air-handling equipment as per the manufacturer’s instructions or more frequently if needed. Vacuum interior of units prior to activation to prevent the aerosolization of dirt, dust and particulates. Ensure filters fit flush in their racks with no spaces in between allowing bypass of unfiltered air into the unit.
8. Use openable windows in conjunction with classroom univents and exhaust vents to increase air exchange. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding.

9. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g., throat and sinus irritations).
10. Ensure plumbing leak in room 113 is repaired. Remediate any water damaged/mold contaminated materials in a manner consistent with recommendations in "Mold Remediation in Schools and Commercial Buildings" published by the US Environmental Protection Agency (US EPA, 2001). Copies of this document can be downloaded from the US EPA website at: http://www.epa.gov/iaq/molds/mold_remediation.html.
11. Seal areas around sinks to prevent water-damage to the interior of cabinets and adjacent wallboard.
12. Once repairs are made, replace water damaged ceiling tiles. Examine the area above and around water-damaged areas for mold growth. Disinfect areas with an appropriate antimicrobial as needed.
13. Contact a masonry firm or general contractor to repair holes/breaches in exterior walls to prevent water penetration, drafts and pest entry. Consider repointing building.
14. Move plants away from outside air intakes and univent air diffusers in classrooms. Ensure all plants are equipped with drip pans. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.

15. Consider discontinuing the use of mulch during or immediately prior to school occupancy to prevent the entrainment of musty odors.

16. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.

17. Store cleaning products properly and out of reach of students. Ensure spray bottles are properly labeled in the event of an emergency. Maintain MSDS for all cleaning products in a central location.

18. Clean fan blades and exhaust and supply vents periodically to prevent excessive dust build-up.

19. Consider replacing tennis balls on chair legs with alternative glides.

20. Consider adopting the US EPA document, "Tools for Schools", to maintain a good indoor air quality environment on the building. This document can be downloaded from the Internet at: http://www.epa.gov/iaq/schools/index.html.

21. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website: http://mass.gov/dph/indoor_air

References

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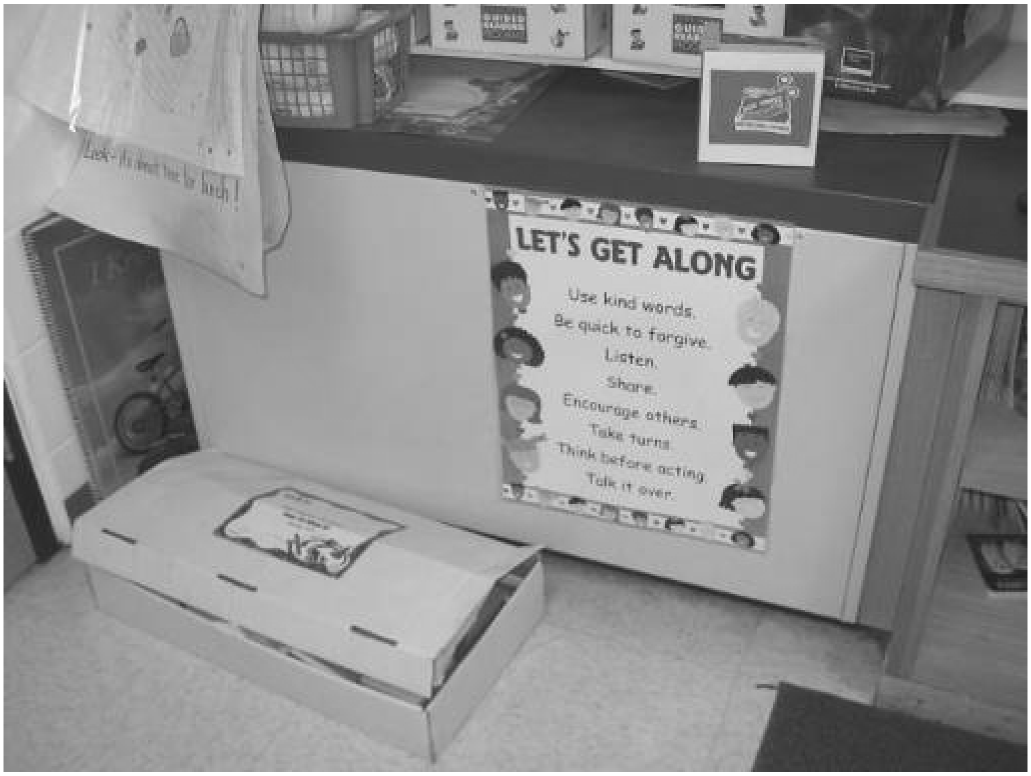
Picture 1

Univent Obstructed by Items on Top and in front of Return Vent (along front/bottom)

Picture 2

Univent Fresh Air Intake, Note Materials in between Louvers

Picture 3

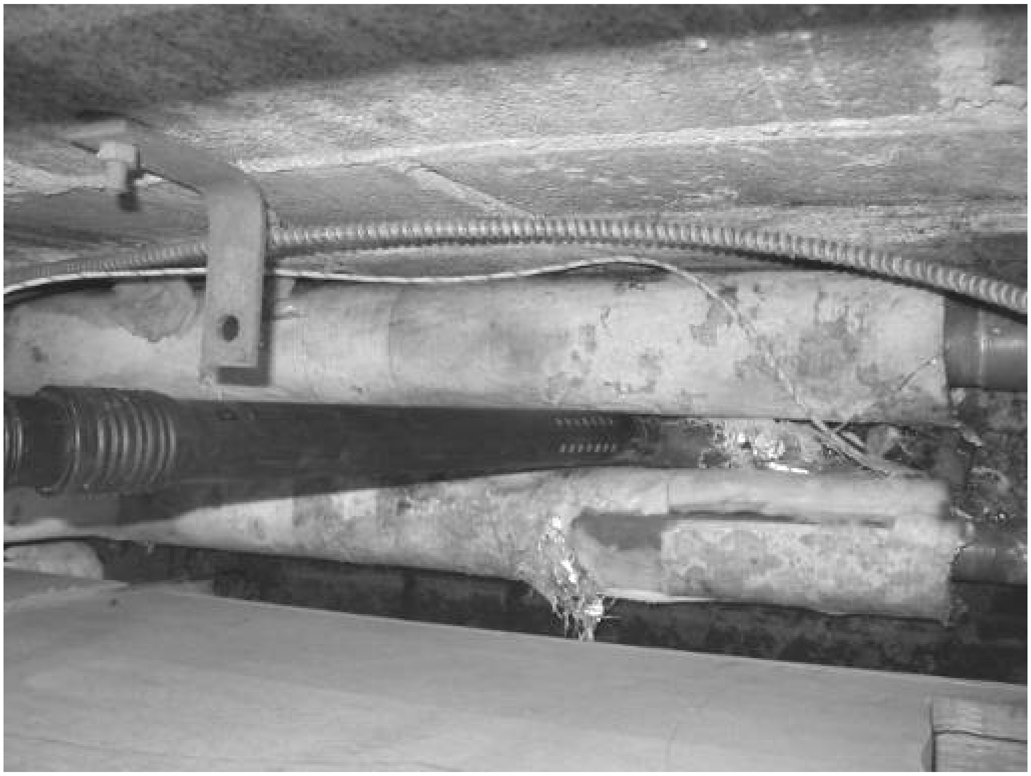


Unit Exhaust Ventilator

Picture 4

Wall-Mounted Exhaust Vent

Picture 5



Water Damaged Insulation in Room 113

Picture 6

Water Damaged Bookcase in Room 113

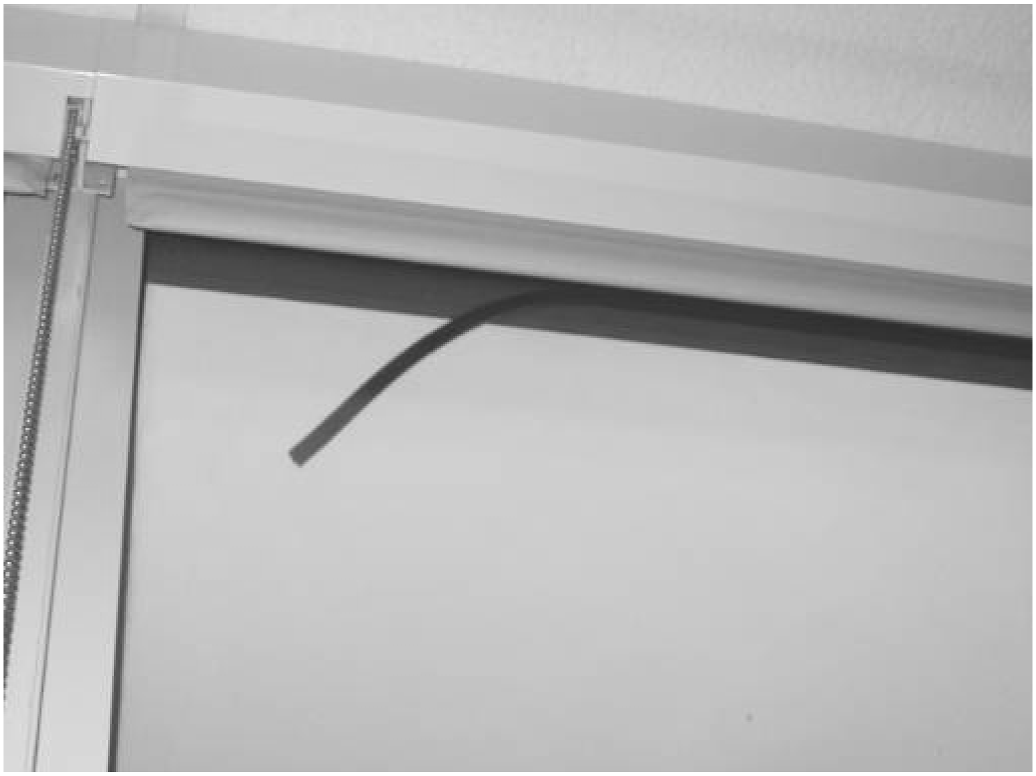
Picture 7

Mulched Area near Univent Air Intake (Indicated by Arrow)

Picture 8

Failing Caulking around Window Frame

Picture 9



Failing Caulking around Window Pane

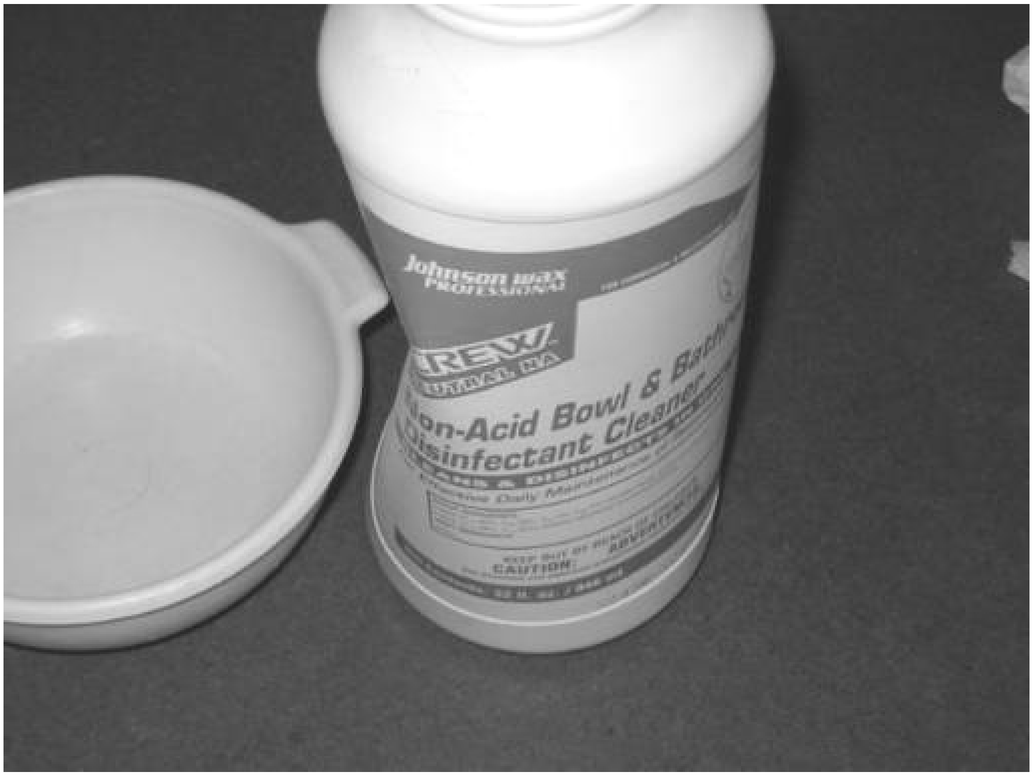
Picture 10

Damaged Brick/Missing Sealant around Univent Air Intake

Picture 11

Space Between Backsplash and Sink Countertop

Picture 12



Cleaning Agent

Picture 13

Cleaning Agents

Picture 14

Tennis Balls on Chair Legs

Picture 15

Examples of Alternative Glides

Summer Street Elementary School
262 Summer Street, Lynnfield, MA 01940

Table 1

Indoor Air Results
Date: 05/09/2006

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (μg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
background		57	45	347	ND	ND	6				winds 10-20 mph, overcast.
teachers' planning room	0	69	31	783	ND	ND	7	Y # open: 0 # total: 0	Y ceiling (weak)	Y ceiling	
teachers' dining room	8	70	32	934	ND	ND	35	Y # open: 0 # total: 2	Y ceiling (weak)	Y ceiling	Hallway DO, UF, high occupancy traffic.
Exam A	0	70	30	1038	ND	ND	6	N	Y ceiling (weak)	Y ceiling	Hallway DO, Inter-room DO,
Nurses' Office	5	71	28	871	ND	ND	6	N	Y ceiling (weak)	Y ceiling	
resting room	0	69	28	896	ND	ND	7	N	Y ceiling (weak)	Y ceiling	Hallway DO, Inter-room DO,
psychologist's office	2	69	28	910	ND	ND	6	N	Y ceiling (weak)	Y ceiling	WD-carpet, cleaners, clorox wipes.

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium

AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials

design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile

NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings

sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
curricular specialist	0	70	28	910	ND	ND	7	N	Y univent	Y ceiling	Hallway DO, PF, wipes.
copy room	2	68	28	841	ND	ND	7	N	Y ceiling	Y ceiling	Hallway DO, cleaners.
main office	0	68	28	824	ND	ND	8	N	Y ceiling	Y ceiling	Hallway DO,
cafeteria	90	69	30	862	ND	ND	10	N	Y ceiling	Y ceiling	Hallway DO,
134	20	72	34	1457	ND	ND	7	Y # open: 0 # total: 6	Y univent items	Y unit exhaust	DEM, cleaners, items, unlabelled bottle.
132	19	74	32	1343	ND	ND	8	Y # open: 0 # total: 6	Y univent	Y unit exhaust (weak)	Hallway DO, DEM, cleaners, items, ceiling fan.
131	0	74	29	1317	ND	ND	7	Y # open: 0 # total: 6	Y univent items	Y unit exhaust	Hallway DO, DEM, cleaners, plants.

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									Supply	Exhaust	
133	18	73	32	1446	ND	ND	9	Y # open: 0 # total: 6	Y univent items dust/debris	Y unit exhaust boxes items	Hallway DO, PC, cleaners, items, plants, unlabelled bottles.
special education	0	73	27	792	ND	ND	7	Y # open: 0 # total: 4	Y ceiling	Y ceiling	Hallway DO, DEM, cleaners, items, plants.
Special education testing	0	71	27	680	ND	ND	6	N	Y ceiling	Y ceiling	Hallway DO, DEM.
122	2	70	28	703	ND	ND	8	Y # open: 0 # total: 3	Y univent items dust/debris	Y unit exhaust	Hallway DO, Inter-room DO, DEM, cleaners.
124	18	70	30	806	ND	ND	9	Y # open: 0 # total: 3	Y univent items dust/debris	Y unit exhaust	Hallway DO, Inter-room DO, DEM, cleaners, dust.

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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Summer Street Elementary School

262 Summer Street, Lynnfield, MA 01940

Table 1

Indoor Air Results

Date: 05/09/2006

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (μg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
123	21	70	31	921	ND	ND	8	N	Y univent items furniture	Y unit exhaust	DEM, cleaners, items.
121	23	72	31	1169	ND	ND	11	Y # open: 0 # total: 3	Y univent	Y unit exhaust (off) items furniture	Hallway DO, Inter-room DO, breach sink/counter, DEM, cleaners, items.
112	27	73	36	1538	ND	ND	14	Y # open: 0 # total: 0	Y univent items dust/debris	Y wall	Hallway DO, DEM, cleaners.
114	26	74	38	2186	ND	ND	9	Y # open: 0 # total: 0	Y univent items furniture	Y wall dust/debris	breach sink/counter, damaged/missing window caulking/gasket, #MT/AT: 1, DEM, TB, unlabelled bottles.
111	0	71	33	1037	ND	ND	9	Y # open: 0 # total: 8	Y univent items	Y wall	Hallway DO, DEM, cleaners, plants.

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262 Summer Street, Lynnfield, MA 01940 **Date: 05/09/2006**

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									Supply	Exhaust	
102	17	73	28	1132	ND	ND	9	Y # open: 0 # total: 8	Y univent items dust/debris	Y wall furniture	Hallway DO, DEM, cleaners, dust, items.
104	40	72	37	1783	ND	ND	21	N	Y univent plant(s)	Y wall dust/debris	DEM, cleaners, items, plants.
105	0	72	33	814	ND	ND	8	Y # open: 0 # total: 8	Y univent furniture	Y wall dust/debris	Hallway DO, DEM.
103	1	71	33	766	ND	ND	10	Y # open: 0 # total: 8	Y univent	Y wall	Hallway DO, DEM, items.
Bathroom	0							N		Y ceiling (off)	strong odor.

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									Supply	Exhaust	
324	26	74	39	1868	ND	ND	9	Y # open: 0 # total: 11	Y univent boxes items dust/debris furniture	Y wall dust/debris	Hallway DO, DEM, cleaners, items, floral odors.
322	26	72	37	1357	ND	ND	10	N	Y univent dust/debris	Y wall	
321 Art	0	71	35	652	ND	ND	9	Y # open: 1 # total: 5	Y univent	Y wall	Hallway DO,
Library	21	73	34	880	ND	ND	7	Y # open: 0 # total: 6	Y univent	Y ceiling	Inter-room DO,
library office	0	73	32	860	ND	ND	8	N	Y ceiling	Y ceiling	Hallway DO, Inter-room DO, items.
library conference	0	73	32	962	ND	ND	8	N	Y ceiling	Y ceiling	Hallway DO, Inter-room DO,

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									Supply	Exhaust	
gym	22	71	35	912	ND	ND	15	N	Y ceiling	Y wall (weak)	Hallway DO,
330	1	71	33	744	ND	ND	8	Y # open: 0 # total: 6	Y univent boxes items furniture	Y wall furniture	Hallway DO, cleaners, plants.
332	0	71	34	787	ND	ND	12	Y # open: 1 # total: 6	Y univent (off) dust/debris furniture	Y wall	Hallway DO, Inter-room DO, univent motor burned out.
gym office	0	73	32	844	ND	ND	12	N	Y ceiling (off)	Y ceiling	
340	24	71	38	1259	ND	ND	17	Y # open: 0 # total: 4	Y univent items dust/debris	Y ceiling	breach sink/counter, DEM, cleaners, plants.

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									Supply	Exhaust	
342	20	73	37	1510	ND	ND	13	Y # open: 0 # total: 4	Y univent items dust/debris	Y ceiling	breach sink/counter, DEM, TB.
344	8	73	37	876	ND	ND	7	Y # open: 0 # total: 4	Y univent dust/debris	Y ceiling	Hallway DO, breach sink/counter, DEM, cleaners, latex gloves.
255	0	71	37	771	ND	ND	9	Y # open: 0 # total: 4	Y univent dust/debris	Y ceiling dust/debris	Hallway DO, breach sink/counter, AD, cleaners, food use/storage, unlabelled bottles.
244 (office)	1	72	37	1149	ND	ND	9	N	Y ceiling	Y ceiling location	Hallway DO, DEM.
246	1	73	35	1219	ND	ND	8	N	Y ceiling	Y ceiling location	DEM, cleaners.
242 speech	1	73	34	1208	ND	ND	9	N	Y ceiling	Y ceiling location	Hallway DO, DEM.

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									Supply	Exhaust	
251	0	73	32	1149	ND	ND	7	N	Y ceiling	Y ceiling location	
245 pt/ot	0	73	32	870	ND	ND	6	N	Y ceiling	Y ceiling	Hallway DO, DEM.
113	0	70	34	668	ND	ND	14	Y # open: 1 # total: 8	Y univent items dust/debris	Y wall furniture	breach sink/counter, damaged/missing window caulking/gasket, #MT/AT: 1, DEM, TB, pipe leak causing water- damage; insulation: med moisture; wood behind coving: high moisture.

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